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TERRESTRIAL MAGNETISM AND ELECTRICITY

BY SIR GEORGE SIMPSON, F.R.S.

The National Research Council of the U.S.A. is publishing a series of monographs on the Physics of the Earth the eighth of which has just appeared*. It is a volume of 794 pages and deals with every aspect of terrestrial magnetism and atmospheric electricity in thirteen chapters each written by an acknowledged authority of whom probably the best known to British readers are J. A. Fleming (The Earth's Magnetism and Magnetic Surveys); O. H. Gish (Atmospheric Electricity), J. Bartels (Some Problems of Terrestrial Magnetism and Electricity), L. Vegard (The Aurora Polaris) and B.F.J.Schonland (Thunder-clouds, Shower-clouds, and their Electrical Effects).

It is an imposing work, but what makes the greatest impression on me is that practically everything described in this volume has been done since I became interested in terrestrial magnetism and atmospheric electricity in 1903. The great advances described in this book can all be traced back to the discovery of ionisation at the end of the last century. Until then terrestrial magnetism consisted of little more than measurements of the

* *Physics of the Earth-VIII: Terrestrial magnetism and Electricity*. Edited by J. A. Fleming, McGraw-Hill, Publishing Company, Ltd., Aldwych House, London, W.C.2.

magnetic field at all parts of the earth and its periodic and secular changes. It is true that Balfour Stewart and Schuster had come to the conclusion that the periodic oscillations could only be explained by a " conducting layer " in the upper atmosphere; but the conductivity of that layer would have to be so high that it seemed an impossibility. Now we have the ionosphere the conductivity of which has been measured and proved to be entirely sufficient to account for the currents required to produce the observed magnetic changes—the very name " ionosphere " indicates its paternity.

In atmospheric electricity it was easy to explain the earth's negative charge when ionisation was unknown. It was just the residual electric charge which remained on the earth when the earth was separated from the sun. With a perfectly insulating atmosphere this charge remained on the surface of the earth, its variation from time to time being due to part of it being carried up into the atmosphere when water evaporated from the surface and returned in the precipitation. With the coming of ionisation all that had to go; a residual charge could not remain on the surface when the atmosphere was conducting. How and why the charge does remain on the surface has been the main problem of atmospheric electricity during the last forty years and this volume describes the attempts to explain it.

The problem of the aurora is a problem of ionisation and without ionisation there would be no thunderstorms and no lightning.

Written as they are by recognised authorities each chapter brings us right up to date in the subject dealt with. It would take too much space to give the titles of the thirteen chapters and it would be invidious to mention any as of more importance than the others. Meteorologists will be most interested in the chapters on Atmospheric Electricity, by O. H. Gish and on Thunder-clouds, Shower-clouds and their Electrical Effects, by B. F. J. Schonland.

The former is a competent survey of the electrical state of the atmosphere below the ionosphere. To one who

has been in the thick of the progress made in atmospheric electricity by the European nations, it is refreshing to see the treatment of the subject by one who has been equally saturated with the work done in the U.S.A. There is no neglect of the work done outside America but naturally nearly all the examples are taken from American work, and the results obtained in the upper atmosphere by *Explorer II* and at sea by the *Carnegie* receive well deserved prominence. Schonland's chapter is, as one would expect from this author, complete and accurate; but it suffers badly from compression. In my opinion the greatest advance in recent years in the domain of the thunderstorm is Schonland's explanation of the mechanism of a lightning discharge and yet his account of this work is contained in eighteen lines!

The National Research Council in publishing their monographs on geophysical subjects are performing a service for which every English speaking geophysicist will be grateful. The standard of the monographs is well sustained in the one under review and the Editor, Mr. J. A. Fleming, is to be congratulated on the team he has got together and on the success of their work.

THE RAINFALL OF 1939

Records show that during the last 22 years the rainfall of January, over the British Isles as a whole, has exceeded the average on 18 occasions; July has given more than the average in each of the last four years; while each August of the last eight years, except one, has been relatively dry. This feature of the monthly rainfall in recent years, *viz.*, a wet January and July, together with a dry August was well marked in 1939.

Over the British Isles generally May gave least rain of any month of the year, while January was the wettest month over England and Wales, and November over Scotland and Ireland. Over England and Wales,

January, 1939, ranks as the wettest January probably since 1764. Over the British Isles, since records began in 1870, May, 1939, ranks as the driest May with but four exceptions; July, 1939, was the wettest July with but two exceptions; August and September, 1939, were together drier than any similar period apart from that of 1933; and November, 1939, was the wettest November apart from that of 1929. Over Scotland, July, 1939, ranks as the wettest July, and over Ireland, November, 1939, was the wettest November on record.

The following are some of the largest daily amounts recorded during the year:—

Blaenau Festiniog (Slate Q.)	Merioneth	5·08 in.	Nov. 25
Loch Quoich (Kinlochquoich)	Inverness	5·05 in.	Feb. 10
Rhondda W. W. (Llyn Fawr Res.)	Glamorgan	4·90 in.	July 6
Rhondda W. W. (Llyn Fawr Res.)	Glamorgan	4·73 in.	Nov. 25
Blandford (Bryanston School)	Dorset	4·66 in.	Aug. 20
Langdale (Middlefel)	Westmorland	4·50 in.	Nov. 25

The total at Llyn Fawr Reservoir for the four days, July 5th to 8th amounted to 10·53 in. and at Blaenau Festiniog and Middlefel for the six days, November 25th to 30th to 12·39 in. and 10·39 in. respectively.

Intense falls of rain were most frequent in 1939 during the thundery spell from July 13th to 21st, details of which are given on pp. 193–199 and pp. 238–239. At Teignmouth 2·38 in. fell in 60 minutes on July 21st. Other striking rains were those of 2·81 in. in 60 minutes at Randalstown (Hollybrook) Co. Antrim on September 3rd and of 2·47 in. in 75 minutes at Frome (Somerset) on August 21st.

There was very little rain over England and Wales from May 18th to June 9th and over Ireland from May 24th to June 9th. At Holne, near Ashburton, there was no measurable rain for the 25 days, May 16th to June 9th, and at Ravenglass, Cumberland, the total for the 45 days, April 26th to June 9th, amounted only to ·44 in. Details of the droughts and dry spells of August and September, which were most widespread in Ireland, are given on pp. 265–7.

Provisional estimates of the general rainfall for 1939

are given below, both in actual inches and as percentages of the average:—

	in.	*Per cent.*
England and Wales	40·3	114
Scotland	48·2	96
Ireland	43·4	100
British Isles	44·0	106

The year 1939 was therefore the fifth consecutive year with a rainfall appreciably in excess of the average, although it was not as wet as either 1935 or 1938. Over England and Wales 1939 ranks as the wettest year since 1930, over Scotland 1939 was drier than 1938 and over Ireland 1939 was drier than each of the previous three years. The main features of the distribution were the large areas in the west of Scotland to the north of the Caledonian Canal and in the west of Ireland with less than 90 per cent. and the large areas in the south-east of England with more than 120 per cent. At Ullapool (Ross-shire) there was only 73 per cent.; while more than 140 per cent. occurred at Wolverton (Bucks), over much of Suffolk and in the east of Kent.

J.G.

LETTERS TO THE EDITOR

The Effect of Strong Gales on Foliage

With regard to the article by S. E. Ashmore in the November issue of the *Meteorological Magazine* on the above subject, the following note may be of interest.

During the very high westerly winds of the late winter and early spring of 1938 extensive discoloration of foliage occurred in the district of Dorset known as the Isle of Purbeck. On one particular occasion when a high wind was unaccompanied by precipitation, salt particles were deposited on surfaces facing the wind direction and were clearly visible on windows, where deposits collected to a thickness of one-sixteenth of an inch in places.

Hawthorn leaves were discoloured to a greater degree

than any other foliage, elm was also affected. The hawthorn leaves dropped off and the trees remained bare for the remainder of the year. Damage to foliage extended from the coast to a distance of approximately five miles inland.

Similar discoloration occurred in this area early in 1939 when precipitation prevented the deposition of salt in the solid state.

H. H. COUTTS.

Meteorological Office, Honington.
December 4th, 1939.

Lunar Rainbows

Since I reported the occurrence of a lunar rainbow on the Hiraethog Mountains on June 6th, 1938 (*Met. Mag.*, 73, 1938, 148), three writers have this year described districts where such occurrences are comparatively frequent; Mr. D. A. Davies on the west coast of Ireland, Mr. G. B. Davie in the Dartmoor district and Mr. T. F. Twist on the west coast of Somerset. The mountainous districts of Wales can be placed in the same category. I have observed another lunar rainbow, this time from the centre of Wrexham, on October 1st, 1939, at 19h. 17m. Only the primary bow was visible but it was so bright that it could be seen from the driving-seat of a car proceeding under black-out regulations and its brilliance attracted the attention of ordinary pedestrians. The difference of illumination of the sky within and without the bow was clearly seen. The shower causing the bow began at 19h. 15m. It was unexpected—in fact this slight shower was the only rain experienced in Wrexham from September 14th to late on October 4th. The sky was completely overcast except for a small patch surrounding the newly-risen Harvest moon, three days past full at the time. The cloud drift was so slow as to be indefinite and it was calm at the surface, but I think that this, too, was an instability shower, influenced by the close proximity of the East Denbighshire mountains. This particular rainbow lasted nearly ten minutes; the claim of North Wales to lunar rainbow

frequency does not lie with the persistence of individual bows, but with the number of bows observed.

S. E. ASHMORE.

11, Percy Road, Wrexham, N. Wales.
October, 21st, 1939.

Largest Annual Total of Sunshine in Britain

A still larger annual total of sunshine than the 2,193 hours at Shanklin for 1911, cited by Capt. J. E. Cowper in the last issue of this magazine, was registered in 1899. The aggregate for that year at Worthing is given on page 64, Vol. XIX, of *The Meteorological Record,* a one-time publication of the Royal Meteorological Society, as 2,207 hours (Campbell-Stokes recorder). At Bexhill, where instruments of both the Campbell-Stokes and Jordan type were then in use, the 1899 total was 2,186 hours by the former and 2,293 hours by the latter.

Incidentally, can anyone point to a smaller annual number of sunless days at a British or Irish station than the 39 which *The Meteorological Record* gives for the year 1906 at Geldeston (Norfolk) and Kingstown (Dublin)?

E. L. HAWKE.

Ivinglea, Dagnall, Bucks.
November 23, 1939.

A Pilot Balloon Returns to its Starting Point

At 17h. G.M.T. on February 23rd, 1939, a 150-in. pilot balloon with an assumed rate of ascent of 700 feet per minute was released from one of H.M. ships lying in Palma Bay, Majorca.

Observations were abruptly curtailed by the balloon entering a layer of stratocumulus; but up to the moment of its loss to view, it had been carried to the north-eastward at a mean velocity of 45 knots.

Twenty-four hours later a balloon was observed, partly deflated, but with only a slight negative atmospheric buoyancy, resting lightly on the surface of

the sea, and drifting past the ship in a westerly surface breeze. On recovery it was identified as that which had been released the previous evening. A pin-prick leak was the cause of descent.

Taking 7h. G.M.T. on February 24th as approximately the mean instant of the balloon's flight, the synoptic chart for this hour shows a depression (about 993 mbs.) centred 100 miles north-west of the ship.

There are two possible solutions to the cause for the balloon's return.

(1) It was carried anti-clockwise round the depression, getting extremely close to the centre whilst in the lower layers, and diverging again at higher altitudes, the reverse taking place on descent.

(2) It obtained its northerly and westerly travel from the cyclonic winds in the east and north sectors of the depression, and at a height of 15,000 feet or more entered the steady north-westerly stream which exists almost continually over the Mediterranean in the upper half of the troposphere. Single theodolite observations of ascents up to assumed heights of 20,000 to 25,000 feet on the previous few days during clearer weather had shown that the predominant wind was from 290°, at speeds varying with the time of day from 20 to 35 knots. Unfortunately no Spanish reports were available from which to enable the upper winds to be traced farther afield or possibly fix the position of a front.

In any case there seems little doubt that the balloon travelled at least 400 miles, and its return to the starting point was the result of an unusual and interesting combination of wind components.

P. G. SATOW.

H.M.S. "Vernon,"
Portsmouth.
October 26th, 1939.

NOTES AND NEWS

Hail Scores Fences at Farnborough, Hants.

A squally thunderstorm visited Farnborough, Hants, on November 6th, 1939, and gave 16·1 mm. of rain and hail between 9h. 30m. and 12h. 44m. G.M.T., of which 5mm. fell in 10 minutes. The thunder was first heard at 9h. 20m. and recurred at intervals till 11h. 30m. G.M.T., and heavy hail was observed at the aerodrome at 9h. 26m. About one mile further north near Farnborough Abbey the hail storm was phenomenally heavy just after 10h., the hail lying for some time in stones the size of large peas; so fierce was the fall here that all wooden fences facing the WSW wind were scored with one or more indentations per square inch and the marks were still visible on the last day of the month in spite of frequent rain during the period.

Squalls of wind from WSW reached 53 m.p.h. at 9h. 30m. and 51 m.p.h. at 12h. 40m. with a quieter period from 10h. 30m. to 10h. 44m. with a mean speed of about 7 m.p.h. Temperature fell from 56° F. at 9h. 30m. to 46° F. at 11h. 30m., the humidity rising from 70 per cent. to 95 per cent.

R. M. POULTER.

Heavy rainfall at Preston, Canterbury, October, 1939.

Mr. J. H. Dyson sends the following account of the rainfall of October from The Old Vicarage, Preston, Canterbury:—

As much as 11·49 ins. occurred in October, compared with a total for the seven months March to September of 12·38 ins. The fall of October includes 3·67 ins. of sleet, snow and hail and thunderstorm rains between 9h. on the 26th and 9h. on the 29th: almost all the precipitation occurred in polar air, the winds having blown nearly continuously from north or east since mid-September. There was nearly an inch of hail in sheltered positions throughout the 27th. Loud thunder and vivid forked lightning were experienced intermittently, the times of the active storms overhead or in the

district being 2h., 7h. 9h., 17h.-23h. at intervals, 23h. 15 m. on the 27th and intermittently until about 2h. on the 28th. This sequence of thunderstorms in polar air was remarkable and all the more interesting in view of the almost complete absence of thunderstorms during the past summer.

Heavy rainfall at Shanklin, October and November, 1939.*

The rainfall at Shanklin (Pomona Road), Isle of Wight, During October and November has been remarkably high. During October 9·49 ins. fell on 19 days, on four or more of which 1 in. or more was recorded. On the 4th there was 1·00 in., 1·12 ins. on the 8th, 1·12 ins. on the 11th and 1·85 ins. on the 13th. During November, 12·54 ins. was recorded on 26 days, of which 1·08 ins. fell on the 6th, 1·38 ins. on the 9th, 1·26 ins. on the 18th and 1·52 ins. on the 23rd.

The previous greatest monthly total since 1906, when the records were commenced, was 11·33 ins. in December, 1934. During November and December, 1934, 15·96 ins. were recorded which was until now the greatest total for two consecutive months. In October and November, 22·03 ins. was the total rainfall. Never before have 4 days in any one month given as much as 1 in. in 24 hours.

At Sandown, the totals were considerably less. The total for October was 7·83 ins. with 1·21 ins. on the 11th and 1·46 ins. on the 13th; for November it was 7·67 ins. and on no day was as much as 1 in. recorded.

Dissipation of Cloud by Aircraft at West Freugh, Stranraer.

At 10h. 15m. G.M.T., on July 18th, 1939, a sheet of stratocumulus at approximately 6,000 feet was spreading across the sky from WSW and had become 5/10, while there was 3/10 cumulus beneath with base at 2,500 feet and tops almost reaching the stratocumulus.

* Based on details supplied by Capt. J. E. Cowper.

The stratocumulus was very thin at the eastern edge and an aircraft flying through it produced clear "lanes" of approximately the width of the wing-span of the machine. The dissipation did not appear immediately behind the aircraft, there being a lag of 3 or 4 seconds between its passage and the formation of the "lane" at any point. The "lanes" had clearly defined edges and persisted for about two minutes. The height of the cloud layer at 12h. G.M.T., was found by pilot balloon to be 5,500 feet.

B. V. BISHOP.

Auroral Notes for October, 1939

In the course of autumn 1939, aurora has been seen several times as far south as Foynes, and during the first three weeks of October it was exceptionally frequent at Lerwick, being observed there on sixteen out of the first twenty nights. Two displays were outstanding, namely, those of October 3rd and October 13th.

The following extracts from notes contributed by Mr. F. E. Dixon relating to observations made by himself and Mr. H. H. Lamb at Foynes on October 3rd and 13th are of interest.

> "On 3rd a diffuse arc was observed at 20h. G.M.T. and shortly afterwards rays reached 55° elevation. There was little activity during the next 1½ hours but the arc persisted with some fluctuations in intensity. Fading always occurred first at the western end of the arc and spread slowly eastwards but the subsequent reappearance was always simultaneous along the whole arc.
>
> At 21h. 41m. when the arc was faint, a brilliant patch of blood-red glow appeared suddenly in the western sky and white rays shot up from between W and NW, some piercing the glow. Red rays also appeared during the next few minutes, and by 21h. 50m. the arc had again become distinct, now in the form of a rayed band.
>
> The red glow in the W and another patch in the NW continued with varying intensity until 22h., but faded finally in the next few minutes. At 22h. 05m. there was only a faint rayed band present and by 22h. 15m. this had dwindled to a single faint patch of glow to the NW. Nothing was seen after 22h. 30m., but a wireless fadeout lasted from about 22h. until the afternoon of October 4th.
>
> On 13th aurora was first seen at 19h. G.M.T. before the twilight glow had disappeared. The sequence of auroral types

was that normally experienced in active displays. At first the only active features were rays to 50° elevation. Multiple arcs then developed and moved S, the principal arc degenerating into a rayed band, and the others fluctuating in intensity. Rays several times passed the zenith and a partial corona formed momentarily about six times between 22h. 25m. and 22h. 45m. During this phase flame aurora also occurred, the flickering being most obvious at the base of the rayed band.

The arc retreated slowly northward after 22h. 45m. and activity diminished. By 22h. 30m. only a faint glow was present and observations were discontinued.

The predominant colour was green throughout but there were considerable patches of red glow to NE and W, and at times the upper parts of rays were of the same tinge. Pale yellow colouration also appeared, especially in the NE.

Other auroral displays occurred on August 11th, 12th and 22nd, September 4th and 17th, October 6th, 15th 16th and 17th most of them comprising only glow.

On nearly every occasion wireless communication with America was interrupted, but there were both fadeouts without aurora and aurora without fadeouts."

Mr. Seton Gordon of Upper Duntuilm, Skye, describes the display of October 3rd as "strange and magnificent." The sky was dusky red in colour low in the west horizon, between Vaternish Point and North Uist. Right overhead at the zenith a whorl of light resembling a giant nebula throbbed and glowed, and here at times the light was deep pink or crimson, waxing and waning in intensity. North, high above the Harris hills, were bright primrose-coloured rays of a greenish tinge, appearing and disappearing in isolated clusters. The whole of the heavens from horizon to horizon seemed to be in motion and the light of the moon failed to diminish the grandeur of this spectacle.

Other reports in less detail were received from Strathy, Wick, Gordon Castle, Aberdeen, Nairn, Leuchars, Paisley, Edinburgh, West Linton, St. Abbs Head and Eskdalemuir.

H. E. C.

PROFESSOR DR. E. G. MARIOLOPOULOS, has been appointed Professor of Meteorology, and Director of the Meteorological Institute in the University of Athens. The formation of the new Institute will be welcomed by all interested in meteorological science.

New Climatological Stations in Scotland.

Through the interest of Mr. J. P. Greig, Convenor of Largo Parish Community Council, a " Health Resort Station " has been set up at Lundin Links, Fife, on the north shore of the Firth of Forth. The observations are being made by Mr. J. D. Ross, M.P.S.

At Newton Stewart, Dumfries-shire, a climatological station has been started by Mr. H. W. Geddie, M.A., the Rector of Douglas-Ewart High School. Observations are under the supervision of Mr. J. C. Frame, the Science Master.

Another new school station is that at Gordonstoun, Elgin, where Mr. F. Spencer Chapman, one of the masters, was responsible for installing the instruments.

An old established climatological station in the Royal Botanic Garden, Edinburgh, has recently been brought up to date by the installation of modern equipment. Through the courtesy of Professor Sir Wm. Wright-Smith, monthly climatological registers are now regularly received in the Meteorological Office, Edinburgh.

Royal Meteorological Society, Symons Gold Medal, 1940

The Council of the Royal Meteorological Society has awarded the Symons Gold Medal for 1940 to Prof. Dr. J. Bjerknes of the Geofysiske Institutt, Bergen. The medal is awarded biennially for distinguished work in connection with meteorological science.

The award to Dr. J. Bjerknes will be very popular among British meteorologists, to whom he has become well known during his frequent visits to this country. In 1932 the Medal was awarded to his father, Prof. V. Bjerknes, and it is fitting that the son, who shared the work, should also share the honours. Dr. J. Bjerknes is well known for his numerous and penetrating memoirs on the structure of barometric depressions and on the mechanism of the atmospheric circulation. J. Bjerknes is still young and we look forward to further important research in future from him and his colleagues.

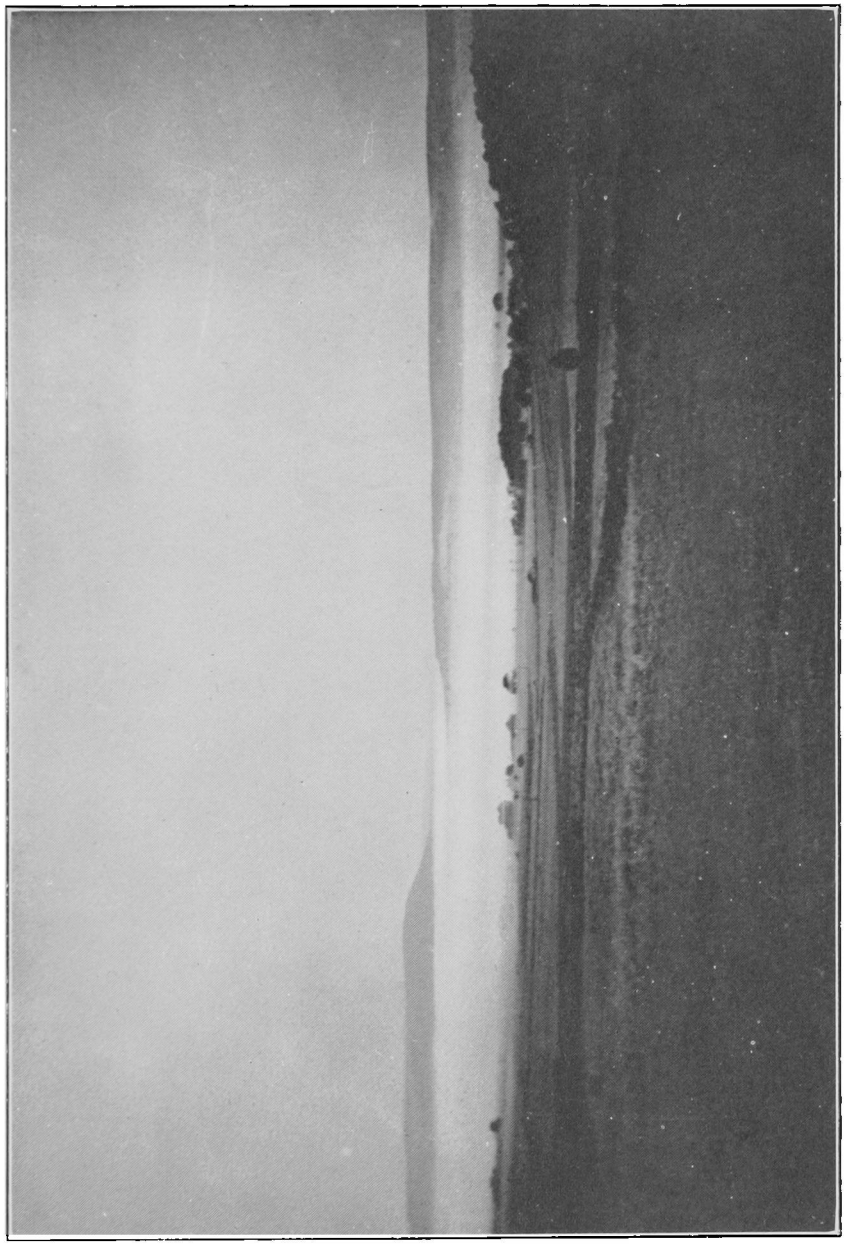
A Ground Fog, August 27th, 1938.

The photograph reproduced opposite is contributed by Mr. T. N. S. Harrower. He remarks that the fog filled the valley of the River Isla, Banffshire. The point of observation was 500 feet above M.S.L. and eight miles distant from the ridge seen on the left. The photograph was taken at 5h. G.M.T. on August 27th, 1938.

Early records of winter thunderstorms (1149, 1258, 1283, and 1791).

Thunderstorms in the winter months have, until recent times, been regarded as irrational and portentous. Everisden writing of the heavy thunderstorm of 26th December, 1283, says that " those who beheld and heard it were struck with exceeding terror and alarm ". Matthew Paris in his account of a heavy storm on 1st December, 1258, adds " in sad presage to all who heard it, thunder in winter always signifying some evil." Even as late as 1791 Richard Brothers (God Almighty's Nephew) quoted the unusually heavy thunder in January of that year as being the voice of the angel mentioned in the 18th chapter of the Book of Revelation proclaiming the Divine judgment upon London. A notable instance of a January thunderstorm is recorded in the Chronicon Scotorum as having happened at Clonmacnoise, Ireland, in 1149. These annals state " Thunder and lightning came in January and the lightning took effect upon the yew tree of Ciaran.....and it killed 113 sheep under the yew." Probably the casualties are exaggerated. This yew tree was reputed to be over 600 years old at the time of the accident. There are many instances of thunderstorms in January to be found in the Chronicles.

C. E. BRITTON.



GROUND FOG IN THE VALLEY OF THE RIVER ISLA, BANFFSHIRE, AUGUST 27TH, 1938

Sunshine, December, 1939

The distribution of bright sunshine for the month was as follows:—

	Total hrs.	Diff. from average hrs.		Total hrs.	Diff. from average hrs.
Stornoway	19	−3	Chester	33	− 8
Aberdeen	20	−17	Ross-on-Wye	49	+ 1
Dublin	25	−21	Falmouth	57	+ 4
Birr Castle	22	−21	Gorleston	..	..
Valentia	66	+26	Kew	35	− 2

Kew temp., mean, 38·3° F. diff. from average −3·1° F.

General Rainfall, December, 1939

	Per cent.
England and Wales	63
Scotland	58
Ireland	72
British Isles	63

REVIEW

Air Temperature and Humidity Data at Mauritius from observations taken at the Royal Alfred Observatory, 1876–1935, by M. Herchenroder. The Royal Alfred Observatory, Mauritius, Misc. Pub. No. 21, Port Louis, 1938.

The discussion of temperature is based on records obtained during the period 1876 to 1935 at the observatory at Pamplemousses, but some reference is also made to an older series of records between 1852 and 1870 at Port Louis; while the discussion of humidity is based on continuous photographic records of dry and wet bulb temperatures during the period 1891 to 1935. The results are carefully set out in numerous tables and graphs and the text occupies 46 pages.

Between 1875 and 1903 dry and wet bulb thermometers were exposed between two open windows in a lofty room in the main building of the observatory. This exposure was regarded as the standard until 1891. Simultaneous observations during a period of 13 years show that the lofty room was sometimes slightly warmer

and sometimes slightly cooler than the thermograph screen, varying according to the time of year and strength of the wind. The exposure of the thermograph screen (Kew photographic thermograph) differs from the conventional exposure of the Stevenson screen owing to the presence of the neighbouring buildings; but the differences between the two screens are revealed by another comparison of simultaneous readings. The author says that while the maxima of temperature in the tropics are probably greater in a Stevenson screen than they would be in an ideal exposure the minima do not appear to be affected likewise. We may mention in this connection that Field decided in 1920, as a result of his experiments in India, that the temperature in the Stevenson screen was only affected appreciably if the air entered the screen on the side warmed by the sun.

A secular change is exhibited in the elements which have been examined at Mauritius, and it takes the form of a steady and prolonged decrease which begins about the year 1905 in the case of pressure, wind speed and temperature and some eight years earlier in rainfall.

J. WADSWORTH.

OBITUARY

M. T. REES. We regret to announce the death on November 17th, 1939, of Mr. M. T. Rees, B.Sc., Technical Officer in the Meteorological Office, from injuries received in a cycle accident.

Mr. Rees, who at the time of his death was only 24 years of age, joined the staff of the Meteorological Office in July, 1938. He was in charge of the station at Penrhos from February to the latter end of August, 1939, when he was transferred to the forecasting staff at Coastal Command Headquarters, Royal Air Force. Although his meteorological experience was comparatively brief it had, nevertheless, been sufficient to show in him qualities of initiative and resource which, added to

his unquestionable scientific ability, gave every expectation of a highly successful career as a meteorologist. His unvarying good humour and engaging manner made him extremely popular with his professional colleagues and the personnel of the flying services alike, and his tragic death is a great loss to the department.

R. E. MONTGOMERY. Mr. Montgomery, who was born in May, 1908, was appointed to a post on the Geological Survey in 1934, upon passing the prescribed examinations. He joined the staff of the Edinburgh office and in 1937 he was transferred to the London office in Exhibition Road, South Kensington. He joined the Meteorological Section of the R.A.F.V.R. as an airman in August, 1939 and was called up on general mobilization. He was one of the unfortunate victims of the railway accident at Bletchley on 13th October, 1939.

G. F. REEVE. Mr. Reeve was born in November, 1899. He was educated at Manchester Grammar School and qualified as a Chartered Accountant. During the last war he saw active service in the Mercantile Marine as a navigating officer. He joined the Meteorological Section of the R.A.F.V.R. as an airman in August, 1939 and passed through the Training School in London. He was posted to a R.A.F. Station for further training and died there very suddenly on the 10th November, 1939.

CORRIGENDA

Mr. H. Arakawa forwards the following correction to his letter, "Height Calculation from the Emagram" in the issue for May, 1939, pp. 111–112.

Page 112, line 16, *for* "on the tephigram" *read* "on the emagram."

Mr. W. D. Flower forwards the following correction to his note, "A constant level water apparatus for wet bulb hygrometers" in the issue for Sept.–Oct., 1939, pp. 242–244.

Page 242, line 29, *for* "two" *read* "four."

Rainfall: December, 1939: England and Wales

Co.	Station.	In.	Per cent of Av.	Co.	Station.	In.	Per cent of Av.
Lond'n	Camden Square.....	·93	39	*Warw*	Birminghm, Edgbaston	1·66	68
Surrey	Reigate, Wray Pk. Rd.	1·85	58	*Leics* .	Thornton Reservoir...	1·61	60
Kent .	Tenterden, Ashenden.	1·56	50	,, .	Belvoir Castle.....	1·35	55
,, .	Folkestone, I. Hospital	1·32	..	*Rutl'd*	Ridlington	..	..
,, .	Margate, Cliftonville..	·83	36	*Lincs*.	Boston, Skirbeck.....	2·20	102
,, .	Edenb'dg.,Falconhurst	1·94	59	,, .	Cranwell Aerodrome..	1·64	74
Sussex	Compton, Compton Ho	2·91	69	,, .	Skegness, Marine Gdns	..	..
,, .	Patching Farm.....	2·20	65	,, .	Louth, Westgate.....	2·86	103
,, .	Eastbourne, Wil. Sq..	1·87	54	,, .	Brigg, Wrawby St....	2·25	..
Hants.	Ventnor, Roy.Nat.Hos.	1·70	52	*Notts* .	Mansfield, Carr Bank..	1·74	60
,, .	Southampton, East Pk	1·84	50	*Derby*.	Derby, The Arboretum	..	..
,, .	Ovington Rectory....	2·13	54	,, .	Buxton, Terrace Slopes	3·19	56
,, .	Sherborne St. John...	1·37	42	*Ches* .	Bidston Obsy.....	2·31	87
Herts .	Royston, Therfield Rec	1·09	47	*Lancs*.	Manchester, Whit. Pk.	2·99	92
Bucks.	Slough, Upton.....	1·08	43	,, .	Stonyhurst College...	3·67	75
Oxford	Oxford, Radcliffe.....	1·42	58	,, .	Southport, Bedford Pk	3·09	96
N'hant	Wellingboro,Swanspool	2·16	92	,, .	Ulverston, Poaka Beck	2·68	49
,, .	Oundle	..	..	,, .	Morecambe.....	2·47	63
Beds .	Woburn, Exptl. Farm.	1·91	82	,, .	Blackpool.....	2·46	75
Cambs	Cambridge, Bot. Gdns.	1·09	56	*Yorks*.	Wath-upon-Dearne...	1·37	58
,, .	March	..	..	,, .	Wakefield,Clarence Pk.	1·54	63
Essex.	Chelmsford,CountyGns	1·00	45	,, .	Oughtershaw Hall....	4·47	..
,, .	Lexden Hill House....	1·17	..	,, .	Harrog'te, HarlowMoor	2·11	70
Suff .	Haughley House.....	·93	..	,, .	Hull, Pearson Park...	2·04	85
,, .	Campsea Ashe, High Ho	1·35	59	,, .	Holme-on-Spalding...	1·78	72
,, .	Lowestoft Sec. School.	2·22	95	,, .	Felixkirk, Mt. St. John	1·93	80
,, .	Bury St. Ed.,WestleyH	1·48	61	,, .	York, Museum.....	1·58	71
Norf..	Wells, Holkham Hall.	2·03	99	,, .	Pickering, Houndgate.	..	..
Wilts .	Porton, W.D. Exp'lStn	1·58	50	,, .	Scarborough.....	2·38	100
,, .	Bishops Cannings	2·23	68	,, .	Middlesbrough.....	1·10	57
Dorset	Weymouth, Westham.	..	..	,, .	Baldersdale, Hury Res.	1·38	37
,, .	Beaminster, East St ..	2·77	58	*Durhm*	Ushaw College.....	1·16	46
,, .	Shaftesbury	1·93	..	*Norl'd*	Newcastle, Leazes Pk.	1·47	63
Devon.	Plymouth, The Hoe...	3·05	61	,, .	Bellingham, Highgreen	1·28	35
,, .	Holne, Church Pk.Cott	5·19	61	,, .	Lilburn Tower Gdns..	1·86	71
,, .	Teignmouth, Den Gdns	1·57	37	*Cumb*.	Carlisle, Scaleby Hall.	1·21	38
,, .	Cullompton	2·55	58	,, .	Borrowdale,Seathwaite	5·00	32
,, .	Sidmouth, U.D.C.....	1·45	..	,, .	Thirlmere,DaleHeadH.	..	..
,, .	Barnstaple,N. Dev.Ath	2·59	58	,, .	Keswick, High Hill...	2·68	40
,, .	Dartm'r,Cranmere P'l	5·95	..	,, .	Ravenglass, The Grove	1·71	37
,, .	Okehampton, Uplands.	4·09	58	*West* .	Appleby, Castle Bank.	1·72	43
Cornw	Bude, School House ..	..	..	*Mon* .	Abergavenny, Larchf'd	1·84	41
,, .	Penzance,Morrab Gdns	3·03	53	*Glam* .	Ystalyfera, Wern Ho..	4·59	55
,, .	St. Austell, Trevarna..	3·72	61	,, .	Treherbert, Tynywaun	..	..
Soms .	Chewton Mendip.....	3·81	71	,, .	Cardiff, Penylan.....	2·72	54
,, .	Long Ashton	2·34	61	*Carm* .	Carmarthen,M.&P.Sc.	4·19	70
,, .	Street, Millfield	1·78	54	*Card* .	Aberystwyth	3·61	..
Glostr.	Blockley	2·00	..	*Radn'r*	Bir. W. W. Tyrmynydd	..	..
,, .	Cirencester, Gwynfa ..	2·47	74	*Mont* .	Lake Vyrnwy.....	..	..
Here .	Ross-on-Wye	1·44	48	*Flint* .	Sealand Aerodrome...	1·77	72
,, .	Kington, Lynhales....	1·80	48	*Mer* .	Blaenau Festiniog....	12·39	107
Salop.	Church Stretton.....	2·29	..	,, .	Dolgelley, Bontddu...	5·68	83
,, .	Shifnal, Hatton Grange	..	..	*Carn* .	Llandudno	2·66	92
,, .	Cheswardine Hall	2·06	73	,, .	Snowdon, L. Llydaw 9	15·90	..
Worc .	Malvern, Free Library.	1·75	63	*Angl* .	Holyhead, Salt Island.	2·47	59
,, .	Ombersley, Holt Lock.	..	..	,, .	Lligwy.....	3·47	..
Warw	Alcester, Ragley Hall.	1·68	68	*I.Man*	Douglas, Boro' Cem...	4·72	96

Rainfall: December, 1939: Scotland and Ireland

Co.	Station.	In.	Per cent of Av.	Co.	Station.	In.	Per cent of Av.
Guern.	St.PeterP't.GrangeRd.	2·99	73	*R&C.*	Stornoway, C.G.Stn...	2·97	50
Wig.	Pt. William, Monreith.	2·43	53	*Suth.*	Lairg	3·11	77
,, .	New Luce School.....	4·65	84	,, .	Skerray Borgie.....	4·34	..
Kirk.	Dalry, Glendarroch...	2·91	41	,, .	Melvich	4·64	108
Dumf.	Eskdalemuir Obs.....	3·09	44	,, .	Loch More, Achfary..	6·21	67
Roxb.	Hawick, Wolfelee	1·40	33	*Caith.*	Wick	3·35	109
,, .	Kelso, Broomlands....	·89	38	*Orkney*	Deerness	..	..
Peebs.	Stobo Castle.....	1·60	42	*Shet.*	Lerwick Observatory.	2·47	51
Berw.	Marchmont House....	1·06	38	*Cork.*	Cork, University Coll.	2·89	56
E.Lot.	North Berwick Res...	·78	36	,, .	Roches Point, C.G.Stn.	3·38	63
Midl.	Edinburgh, Blackfd. H	·88	38	,, .	Mallow, Hazlewood ..	2·83	..
Lanark	Auchtyfardle	1·98	..	*Kerry.*	Valentia Observatory.	4·43	67
Ayr.	Kilmarnock, Kay Park	2·92	..	,, .	Gearhameen	9·50	76
,, .	Girvan, Pinmore	3·45	41	,, .	Bally McElligott Rec.	3·24	..
,, .	Glen Afton, Ayr San..	3·38	53	,, .	Darrynane Abbey....	3·20	54
Renf.	Glasgow, Queen's Park	2·46	58	*Wat.*	Waterford, Gortmore.	2·75	60
,, .	Greenock, Prospect H.	3·06	41	*Tip.*	Nenagh, Castle Lough.	3·31	72
Bute.	Rothesay, Ardencraig.	3·46	63	,, .	Cashel, Ballinamona..	3·22	75
,,	Dougarie Lodge.....	3·63	66	*Lim.*	Foynes, Coolnanes....	2·82	59
Argyll	Loch Sunart, G'dale..	5·62	65	,, .	Limerick, Mulgrave St.	..	..
,,	Ardgour House	5·10	..	*Clare.*	Inagh, Mount Callan..	4·86	..
,,	Glen Etive	3·05	25	*Wexf.*	Gorey, Courtown Ho..	2·81	74
,,	Oban	3·70	..	*Wick.*	Rathnew, Clonmannon	2·43	..
,,	Poltalloch	4·06	64	,, .	Blessington Rectory..	..	..
,,	Inveraray Castle	4·96	50	*Carlow*	Bagnalstown FenaghH	2·74	73
,,	Islay, Eallabus	5·30	89	,, .	Hacketstown Rectory.	2·85	69
,,	Mull, Benmore.....	..	..	*Leix.*	Blandsfort House	2·75	75
,,	Tiree	3·93	75	*Offaly.*	Birr Castle	2·22	67
Kinr.	Loch Leven Sluice....	1·51	38	*Dublin*	Dublin, Phoenix Park.	2·01	79
Fife.	Leuchars Aerodrome..	·82	33	*Meath.*	Kells, Headfort.....	3·20	84
Perth.	Loch Dhu	5·30	53	*W.M.*	Moate, Coolatore.....	2·39	..
,, .	Crieff, Strathearn Hyd.	2·60	58	,, .	Mullingar, Belvedere..	3·12	85
,, .	Blair Castle Gardens..	1·97	52	*Long.*	Castle Forbes Gdns ..	3·09	78
Angus.	Kettins School.....	1·76	53	*Galway*	Galway, Grammar Sch.	3·01	66
,, .	Pearsie House	2·65	..	,, .	Ballynahinch Castle ..	5·11	68
,, .	Montrose, Sunnyside..	1·14	41	,, .	Ahascragh, Clonbrock.	2·87	61
Aberd.	Balmoral Castle Gdns.	1·56	46	*Rosc.*	Strokestown, C'node..	3·01	80
,, .	Logie Coldstone Sch ..	..	..	*Mayo.*	Blacksod Point	3·77	62
,, .	Aberdeen Observatory.	1·65	51	,, .	Mallaranny.....	6·31	..
,, .	New Deer SchoolHouse	2·58	75	,, .	Westport House.....	3·83	67
Moray	Gordon Castle	2·92	109	,, .	Delphi Lodge.....	7·34	60
,, .	Grantown-on-Spey ...	2·09	77	*Sligo.*	Markree Castle.....	4·57	97
Nairn.	Nairn.....	1·93	87	*Cavan.*	Crossdoney, Kevit Cas.	3·61	..
Inv's.	Ben Alder Lodge.....	..	..	*Ferm.*	Crom Castle	3·66	88
,, .	Kingussie, The Birches	1·75	..	*Arm'h*	Armagh Obsy.....	2·35	75
,, .	Loch Ness, Foyers....	2·00	45	*Down.*	Fofanny Reservoir ...	5·79	..
,, .	Inverness, Culduthel R	1·91	71	,, .	Seaforde	2·13	52
,, .	Loch Quoich, Loan...	7·41	..	,, .	Donaghadee, C. G. Stn.	2·99	94
,, .	Glenquoich	8·15	56	*Antrim*	Belfast,Queen's Univ .	2·60	71
,, .	Arisaig House	3·94	54	,, .	Aldergrove Aerodrome	3·04	89
,, .	Glenleven, Corrour ...	4·50	49	,, .	Ballymena, Harryville.	3·67	83
,, .	Ft. William, Glasdrum	3·50	..	*Lon.*	Garvagh, Moneydig...	3·77	..
,, .	Skye, Dunvegan	4·19	..	,, .	Londonderry, Creggan.	3·94	90
,, .	Barra, Skallary	3·80	..	*Tyrone*	Omagh, Edenfel.....	3·65	86
R&C.	Tain, Ardlarach.....	2·62	84	*Don.*	Malin Head.....	2·97	72
,, .	Ullapool	2·72	43	,, .	Dunfanaghy	3·17	70
,, .	Achnashellach	3·70	37	,, .	Dunkineely.....	3·27	..

Climatological Table for the British Empire, June, 1939

STATIONS.	PRESSURE.		TEMPERATURE.							Relative Humidity.	Mean Cloud Am'nt	PRECIPITATION.			BRIGHT SUNSHINE.	
			Absolute.		Mean Values.				Mean.							
	Mean of Day M.S.L.	Diff. from Normal.	Max.	Min.	Max.	Min.	½ Max. and Min.	Diff. from Normal	Wet Bulb.			Am'nt.	Diff. from Normal.	Days.	Hours per day.	Percentage of possible.
	mb.	mb.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	%	0–10	in.	in.			
London, Kew Obsy.	1016·8	+ 0·1	85	44	66·6	51·6	59·1	+ 0·1	52·2	76	6·3	1·15	— 1·00	9	7·3	45
Gibraltar	1016·2	— 1·1	83	56	72·7	60·9	66·8	— 3·7	59·9	80	2·8	0·69	—	4	10·8	75
Malta	1014·2	— 1·0	91	58	77·1	65·1	71·1	— 1·6	63·6	69	2·0	0·00	— 0·09	0	12·4	86
St. Helena	1018·3	— 1·7	74	54	66·9	57·4	62·1	+ 2·3	59·0	81	6·4	1·38	— 1·44	11	—	—
Freetown, Sierra Leone	1012·9	+ 2·6	90	69	87·3	73·0	80·1	—	73·2	89	8·4	13·95	— 6·09	22	—	—
Lagos, Nigeria	1012·3	— 0·1	88	69	84·0	72·0	78·0	— 1·5	73·3	93	8·1	15·73	— 2·75	18	5·8	47
Kaduna, Nigeria	1011·5	—	91	61	85·0	66·8	75·9	— 0·8	69·8	89	5·7	8·98	+ 1·89	20	7·7	61
Zomba, Nyasaland	1018·8	+ 1·1	75	51	69·8	54·0	61·9	— 1·0	57·5	82	7·0	1·14	+ 0·66	8	—	—
Salisbury, Rhodesia	1022·5	+ 0·3	73	38	65·8	43·2	54·5	— 2·4	48·7	69	3·4	0·18	—	6	7·9	71
Cape Town	1021·2	+ 1·1	83	35	71·8	48·3	60·1	+ 4·4	50·9	82	4·6	1·94	— 2·56	8	—	—
Johannesburg	1023·9	+ 1·7	67	36	60·6	41·6	51·1	+ 0·4	41·6	53	0·8	0·00	— 0·14	0	9·0	86
Mauritius	1019·1	+ 0·3	79	56	75·9	62·1	69·0	— 0·4	66·0	71	5·1	3.58	+ 1·17	14	7·1	65
Calcutta, Alipore Obsy.	999·4	— 0·3	103	74	93·4	79·7	86·5	+ 1·4	81·0	85	8·6	15·20	+ 3·29	12*	—	—
Bombay	1004·6	+ 0·6	94	75	89·7	79·8	84·7	+ 0·7	78·5	79	6·5	4·67	—15·20	10*	—	—
Madras	1003·9	+ 0·1	110	77	100·1	81·9	91·0	+ 1·0	74·7	53	6·1	1·05	— 0·92	3*	—	—
Colombo, Ceylon	1010·0	+ 1·4	88	73	85·2	77·6	81·4	— 0·2	77·9	82	8·2	6·25	— 1·07	22	5·5	44
Singapore	1009·2	+ 0·3	89	72	85·8	76·3	81·1	— 0·4	77·4	77	6·8	5·67	— 1·20	15	5·8	48
Hongkong	1006·5	+ 0·7	89	71	85·7	78·2	81·9	+ 0·5	77·7	84	8·3	8·65	— 7·05	20	4·5	33
Sandakan	1009·2	—	90	75	87·6	77·1	82·3	+ 0·6	76·8	83	7·7	5·32	— 2·18	12	—	—
Sydney, N.S.W.	1013·6	— 4·3	70	42	64·4	48·7	56·5	+ 1·8	49·3	69	4·2	0·72	— 4·02	5	6·3	64
Melbourne	1012·9	— 5·6	62	38	58·0	44·4	51·2	+ 0·8	47·1	82	7·8	3·09	+ 1·03	15	2·5	26
Adelaide	1014·9	— 4·5	67	42	62·3	47·8	55·1	+ 1·5	51·1	83	7·3	4·25	+ 1·17	17	4·2	43
Perth, W. Australia	1015·1	— 2·9	71	44	64·7	49·1	56·9	+ 0·1	52·1	77	5·7	11·15	+ 4·21	18	5·2	52
Coolgardie	1017·1	— 2·8	73	34	62·4	42·5	52·5	— 0·3	48·0	81	4·3	1·32	+ 0·06	6	—	—
Brisbane			76	43	69·3	51·6	60·5	+ 0·3	54·2	71	3·6	2·44	— 0·35	5	7·0	67
Hobart, Tasmania	1008·4	— 5·9	61	35	54·2	42·9	48·5	+ 1·5	43·8	77	6·8	4·05	+ 1·82	16	3·9	43
Wellington, N.Z.	1010·2	— 4·7	63	38	56·1	45·5	50·8	+ 1·3	47·9	81	7·0	3·42	— 1·35	14	3·5	38
Suva, Fiji	1014·9	+ 1·3	86	64	79·6	68·8	74·2	— 0·5	68·6	80	5·1	2·07	— 4·64	17	5·2	47
Apia, Samoa	1011·6	0·0	89	67	84·6	72·5	78·5	+ 0·7	73·4	74	3·4	1·57	— 3·78	7	9·1	81
Kingston, Jamaica	1014·2	+ 0·4	93	71	88·1	73·6	80·9	— 0·4	72·6	76	3·6	1·61	— 2·49	9	7·4	56
Grenada, W.I.	1010·8	— 2·5	89	70	87·0	74·0	80·5	+ 1·5	74·0	79	7·0	10·13	+ 1·88	22	—	—
Toronto	1014·7	0·0	89	47	74·1	56·9	65·5	+ 1·7	56·8	76	6·1	1·91	— 0·75	10	8·4	56
Winnipeg	1011·6	— 0·2	86	37	69·7	48·4	59·1	— 3·2	50·7	85	6·3	2·49	— 0·62	12	7·4	45
St. John, N.B.	1014·7	+ 1·2	83	42	65·9	48·0	56·9	+ 0·4	51·3	76	5·1	3·89	+ 0·62	16	8·5	54
Victoria, B.C.	1017·2	+ 0·4	70	44	61·8	49·1	55·5	— 1·5	52·1	83	6·6	1·23	+ 0·39	11	7·3	46

(50384) Wt. 22/31 1,250 1/40 Hw. G.377/6